Topic Area – Geologic Sequestration, Saline Formations

The Ohio River Valley CO_2 Storage Project - Characterization of Site-Specific Sequestration Potential

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The current phase of the Ohio River Valley CO_2 Storage Project is in its final year. The principal objectives of this phase are to characterize hydrogeologic conditions and sequestration potential of selected candidate reservoir horizons at the Mountaineer Power Plant and the surrounding Ohio River Valley Region. These objectives have been achieved through analysis of available field hydrogeologic characterization data, and using these analysis results as input for reservoir simulations, risk assessment, and the design and evaluation of potential injection and monitoring scheme scenarios. In addition the project has also involved substantial stakeholder efforts. The field characterization work included the planning and drilling of a 9,190-ft deep test borehole. The borehole was characterized using a full suite of wireline borehole geophysical tools, core collection and analysis, brine analysis, and reservoir hydraulic testing. A 2-dimensional seismic survey was also conducted in the parts of Ohio and West Virginia surrounding the plant. This presentation provides a broad overview of the project status and its findings, including the assessment of hydrogeologic data collected at the site, overview of injection potential, and summary of the associated activities including the reservoir simulations, stakeholder interactions, risk assessment, and evaluation of injection and monitoring strategies. The findings presented were made possible by cooperative technical contributions provided by a large team of experts and the financial assistance from DOE-NETL, AEP, BP, OCDO, Schlumberger, Battelle, and PNNL, as well as, several additional vendors.

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Alexandria, May 4, 2004

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AEP

bp

BURN OHIO COAL
Ohio Coal Development Office

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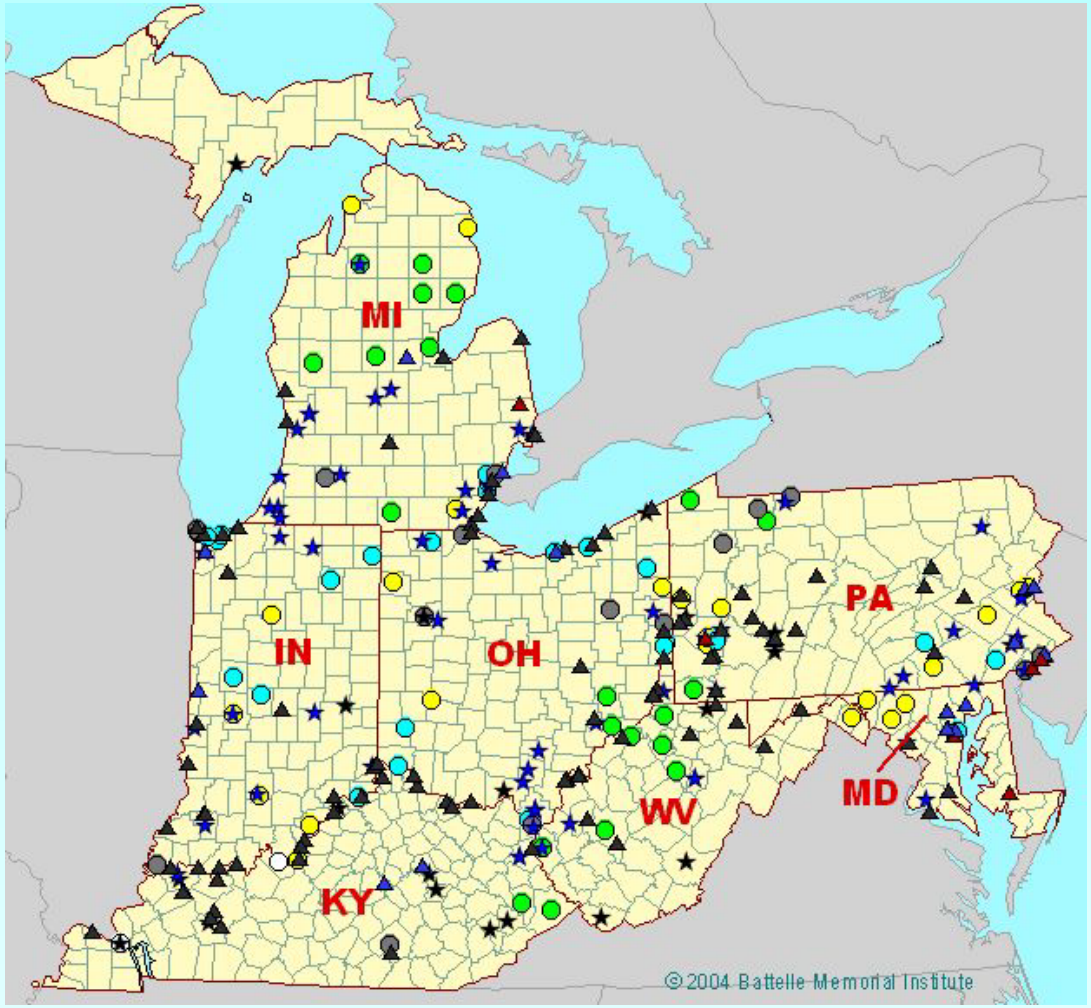
Ohio River Valley CO_2 Storage Project

- *The Ohio River Valley Project is being conducted at Mountaineer*
- *The primary objective of the project is to characterize the site and its vicinity for CO_2 storage potential in various geologic reservoirs*
- The major tasks include:
  - Geologic characterization through **seismic survey and deep well drilling**
  - Reservoir simulations and risk assessment
  - Conceptual design (but not construction) of injection and monitoring system
  - Stakeholder outreach
- No CO_2 is being injected during this phase and no decision about potential future phases can be made until we fully understand the data that has been collected about potential formations.

Major CO_2 Sources in Ohio River Valley Region

- A very large number of CO_2 sources are present in the study region
- Therefore, it is critical to determine and quantify CO_2 sequestration options for this region through the Partnership
- At the same time, the Mountaineer project provides a protocol for site characterization under realistic setting in this and other regions



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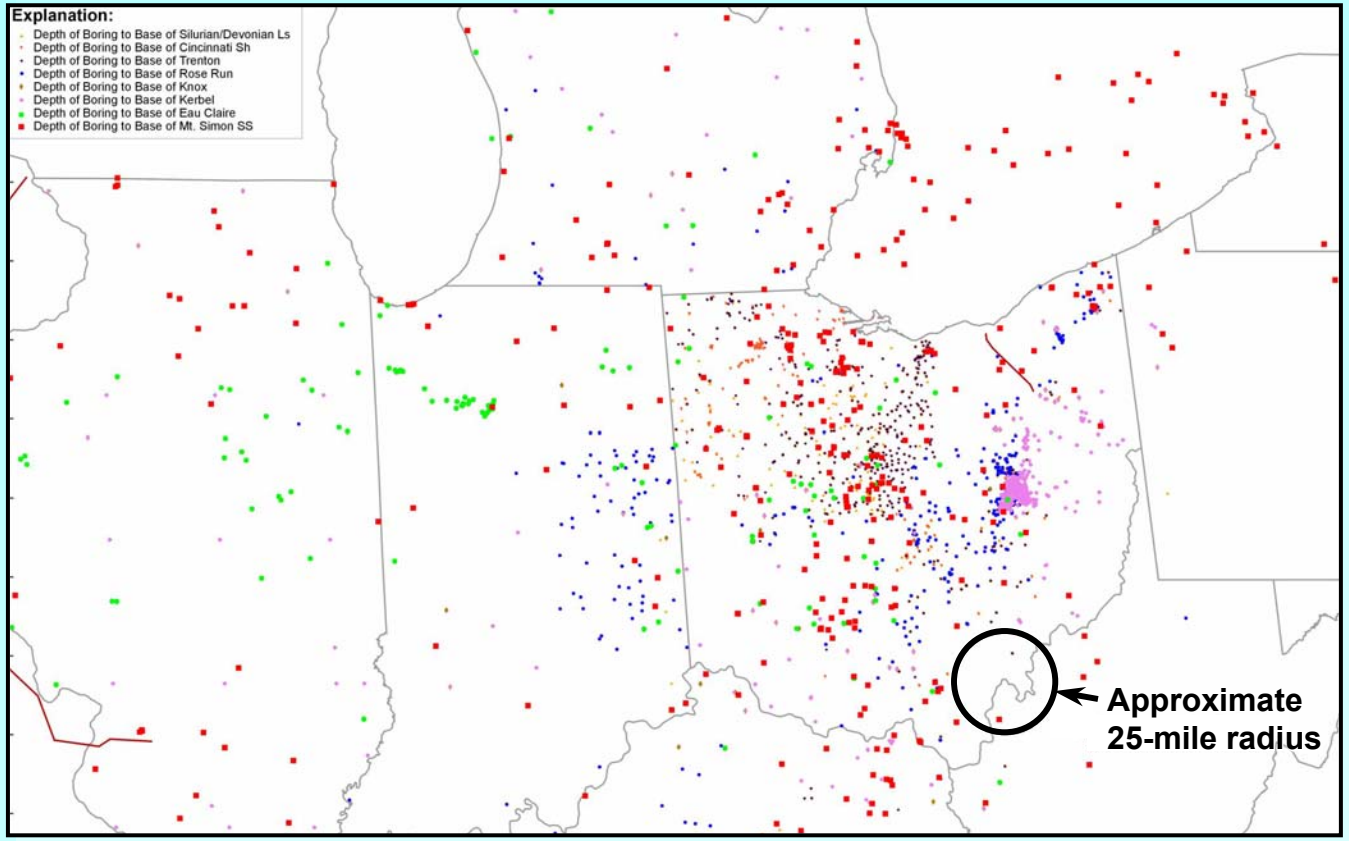
Why Drill a Test Well?
Deep Well Coverage (Partial) in the Midwest



- Almost no deep drilling has been performed in the area of interest. Therefore, a new deep test well is needed so that we can understand the subsurface geology and how it would respond to CO_2 injection.

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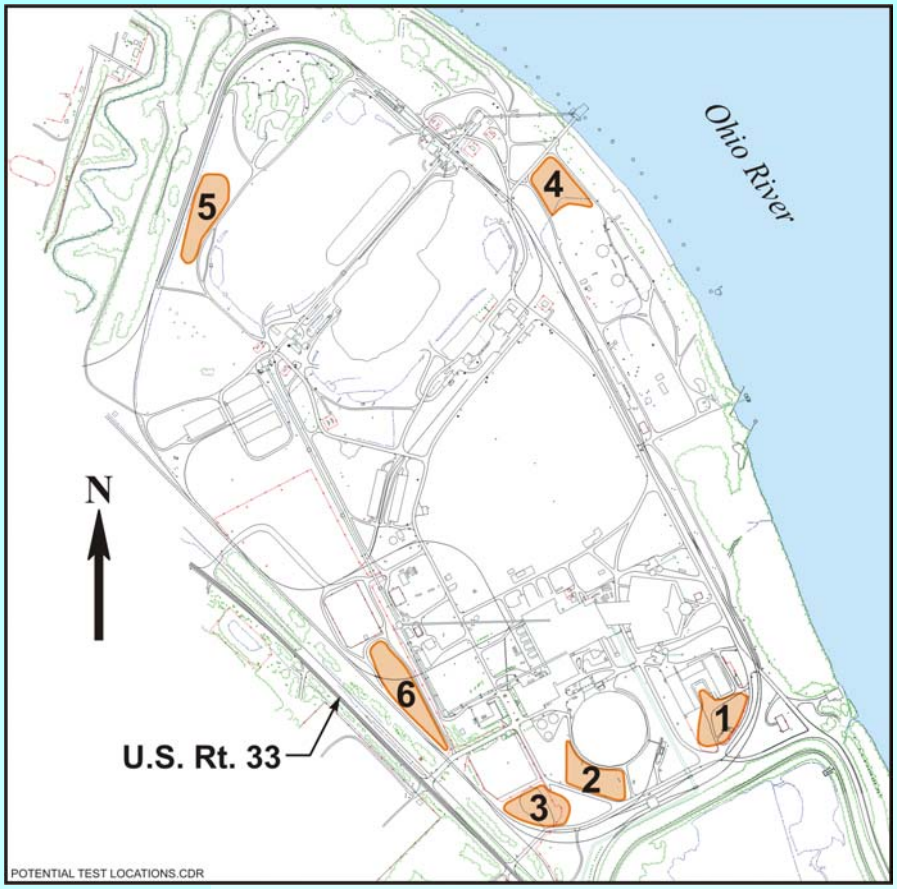
Selecting the Site for the Deep Well Drilling –
Balancing the Needs of the Power Plant and the Research Project



Site #3 was eventually selected as it best met the needs of the sequestration project and the power plant's day-to-day operations

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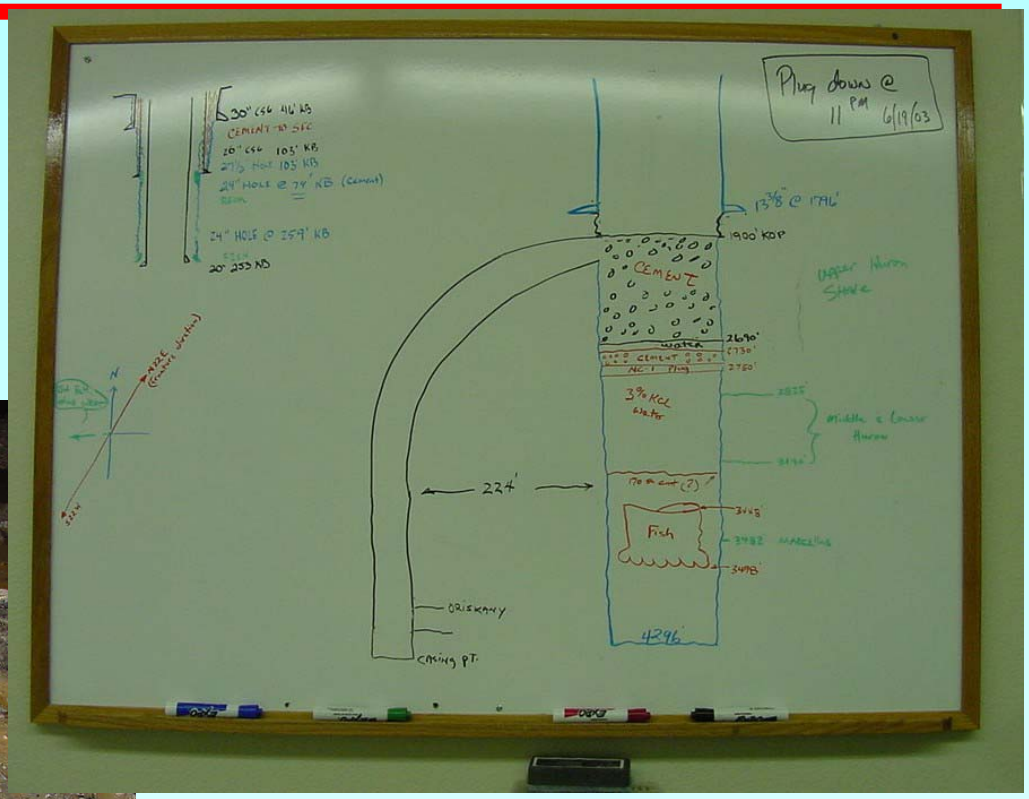
Drilling Pictures

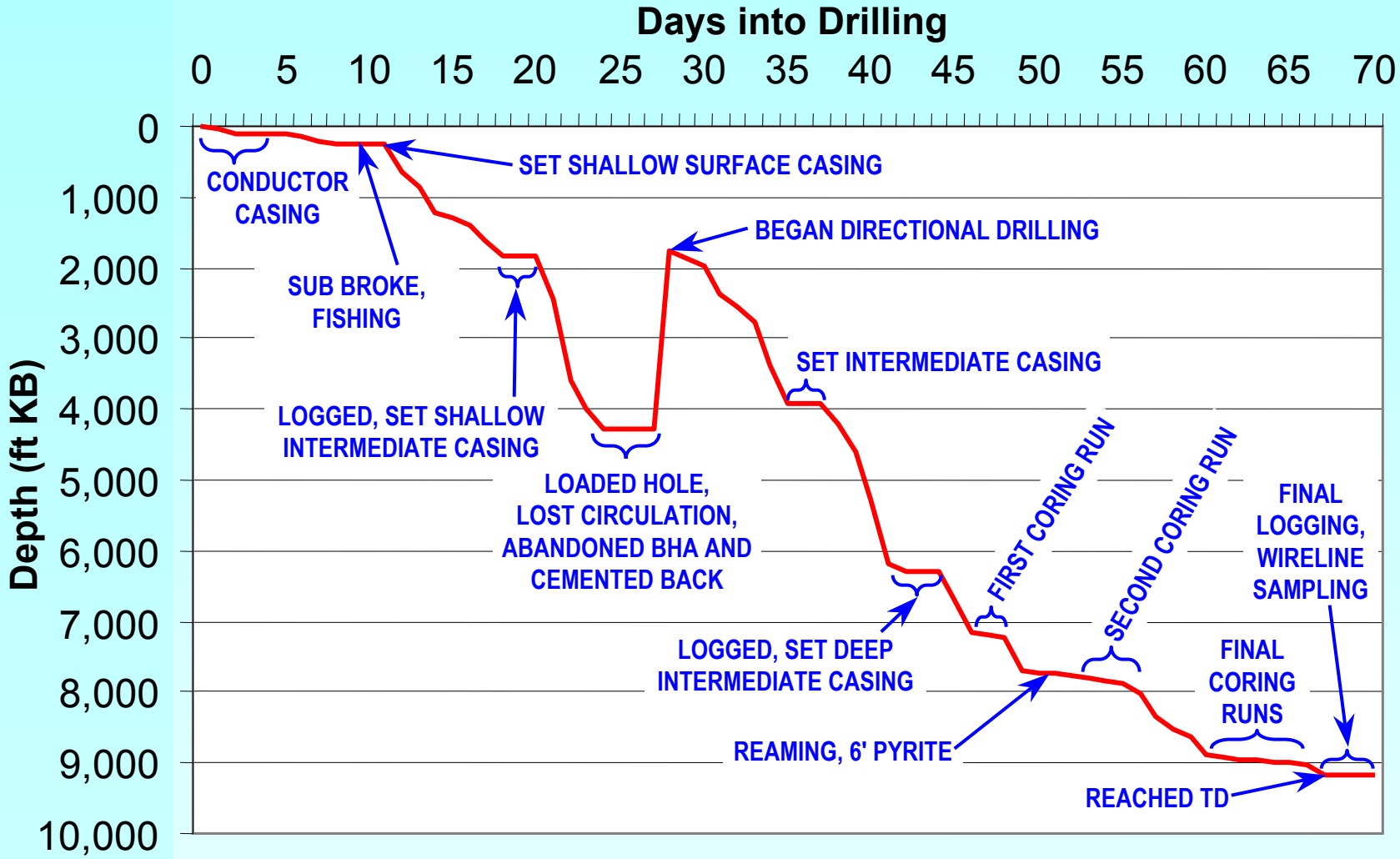
26-in conductor casing being installed.

Setting 13-inch Casing

Directional Drilling to bypass lost circulation



Drilling Progress and Major Events



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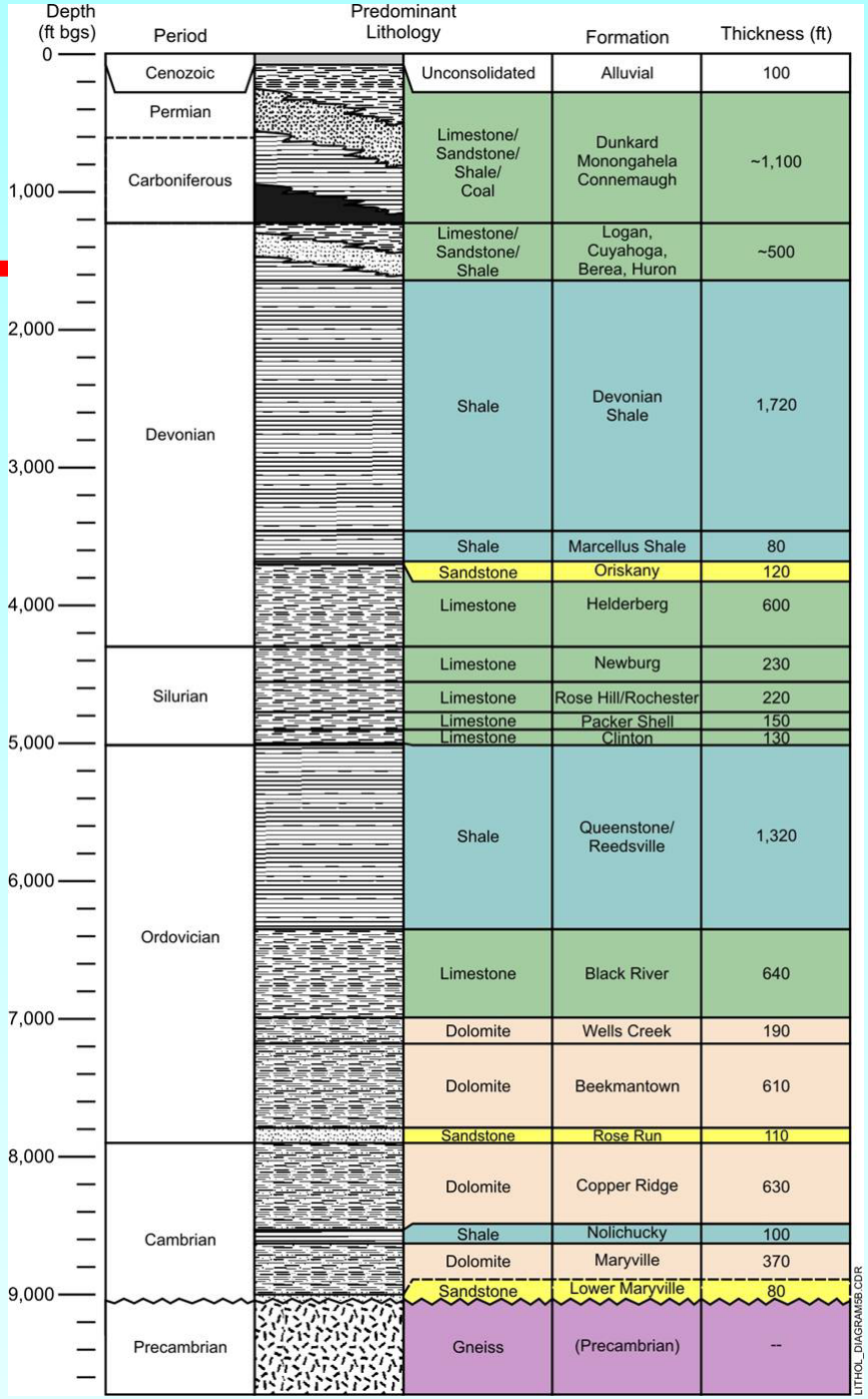
General Stratigraphy

- 9,200 ft of Paleozoic sedimentary rocks (shale, limestone, dolomite, and sandstone) overlie Pre-Cambrian rocks
- *Mt. Simon Sandstone, present in most of the midwestern states, appeared likely to be absent at the site*
- Geologic nomenclature for the basal sand in the area is not well defined due to lack of data
- The Basal Sandstone and the Rose Run sandstone may be the most appealing injection targets in the region
- Containment is excellent as the low permeability confining layers are thick and extensive



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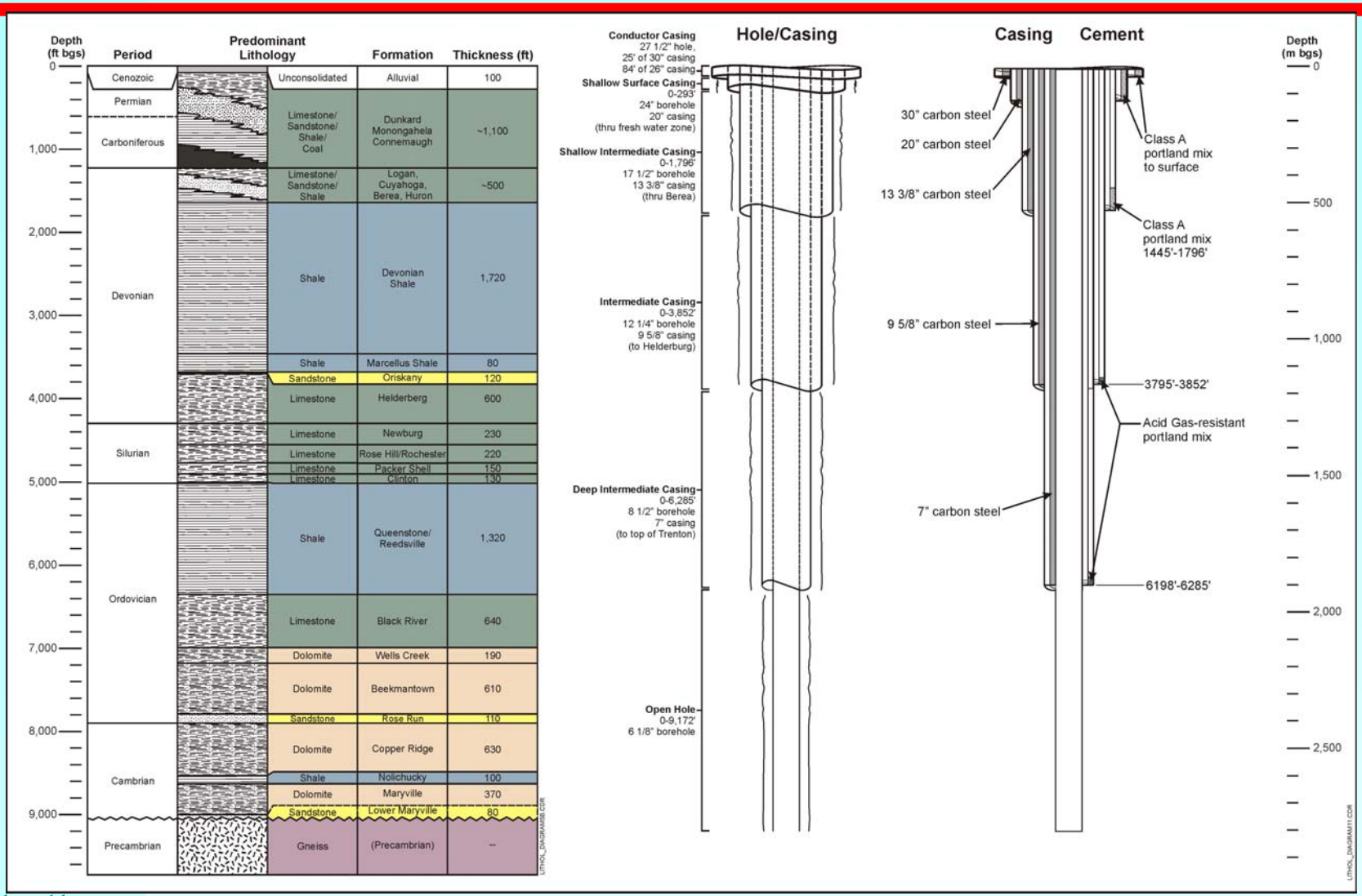
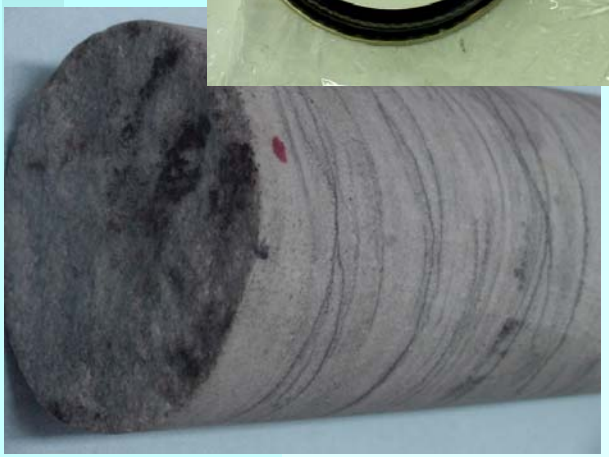
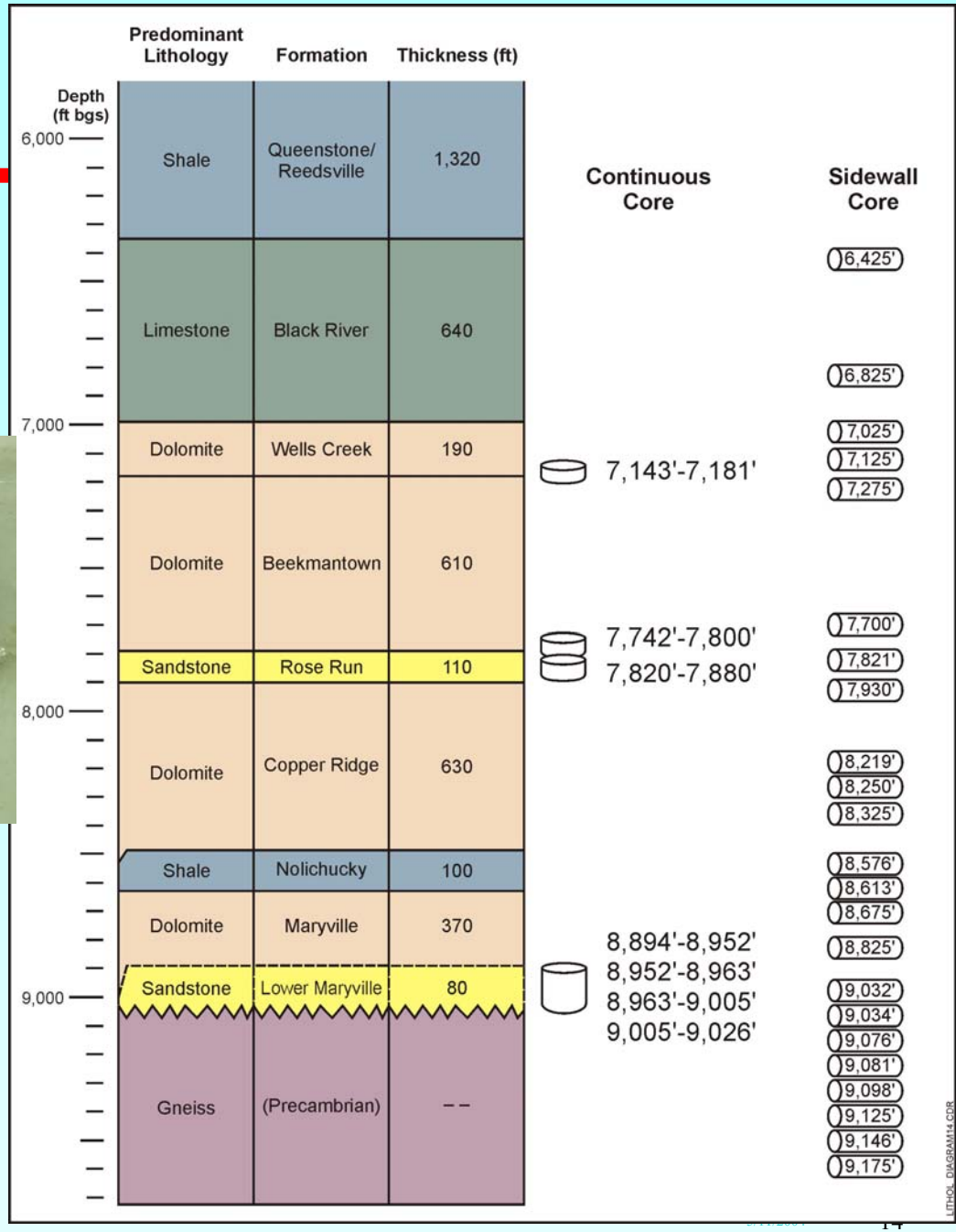
Completed Well Configuration



293 ft of Full-Core and 23 Sidewall Cores Collected





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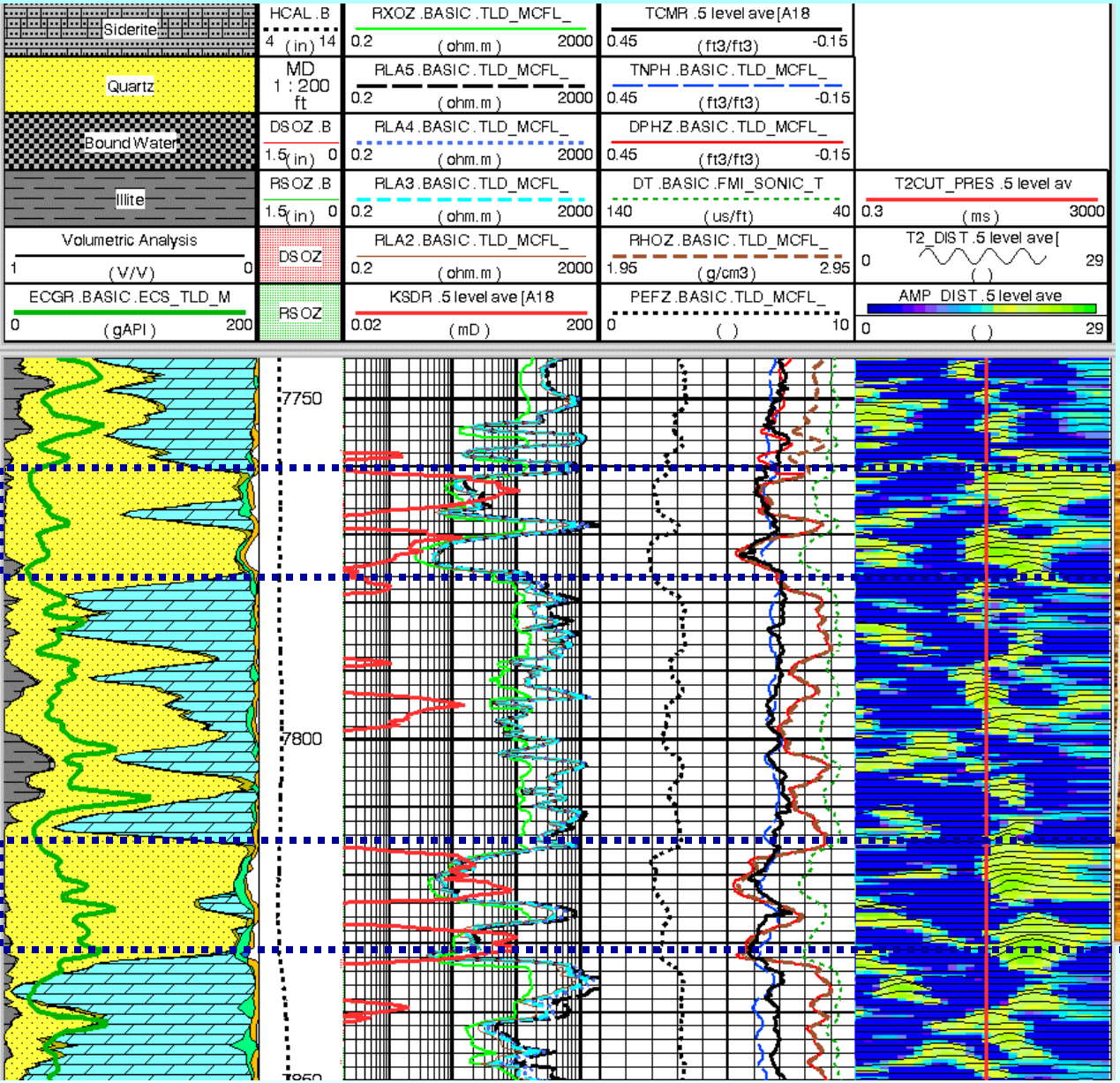
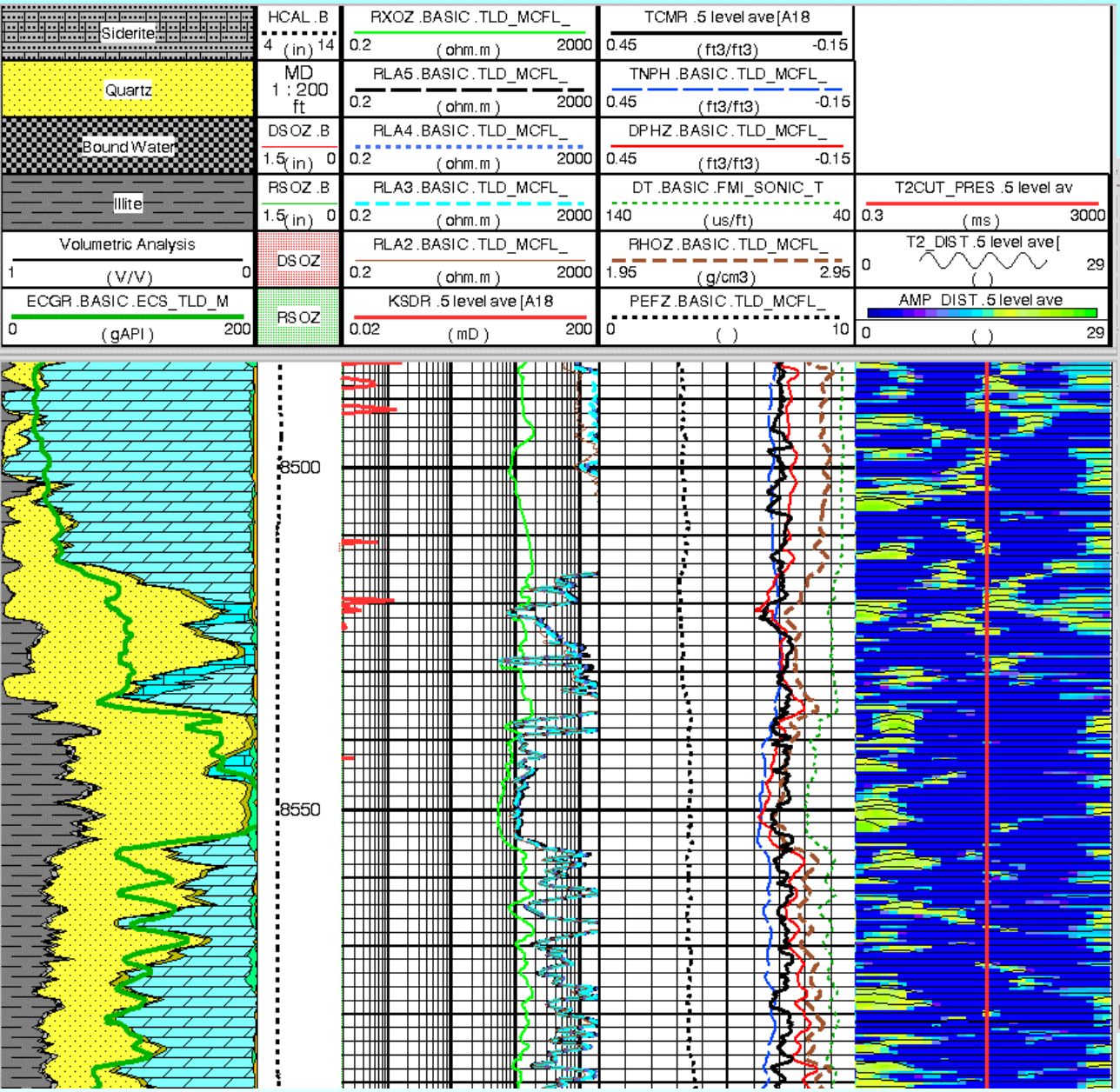
Borehole Logging – Rose Run Sandstone (~7,800 ft deep)

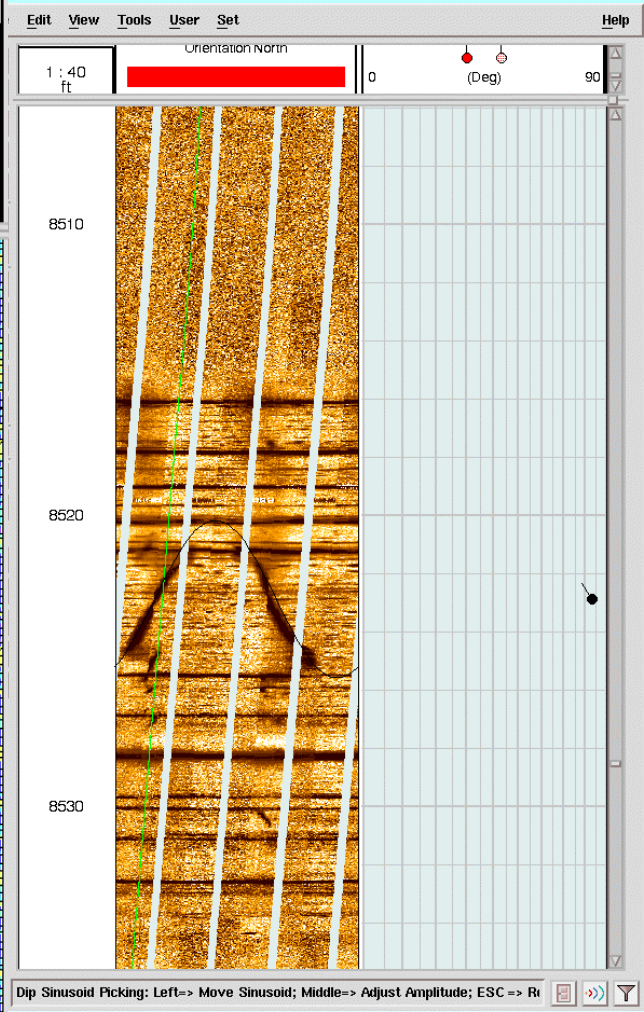


Zone of Greater Permeability

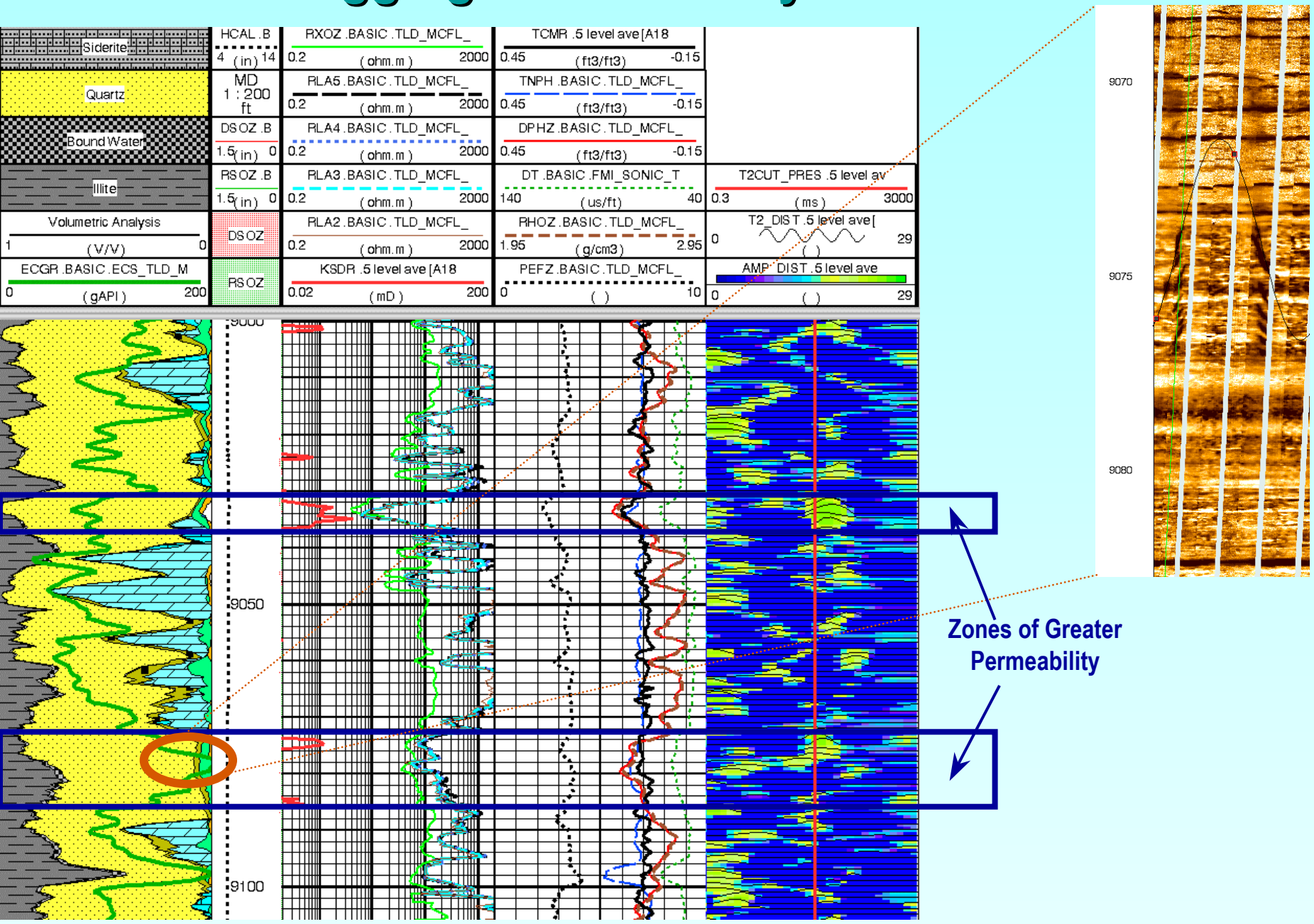
Zone of Greater Permeability

Copper Ridge Dolomite – Nolichuky Shale (8520’)





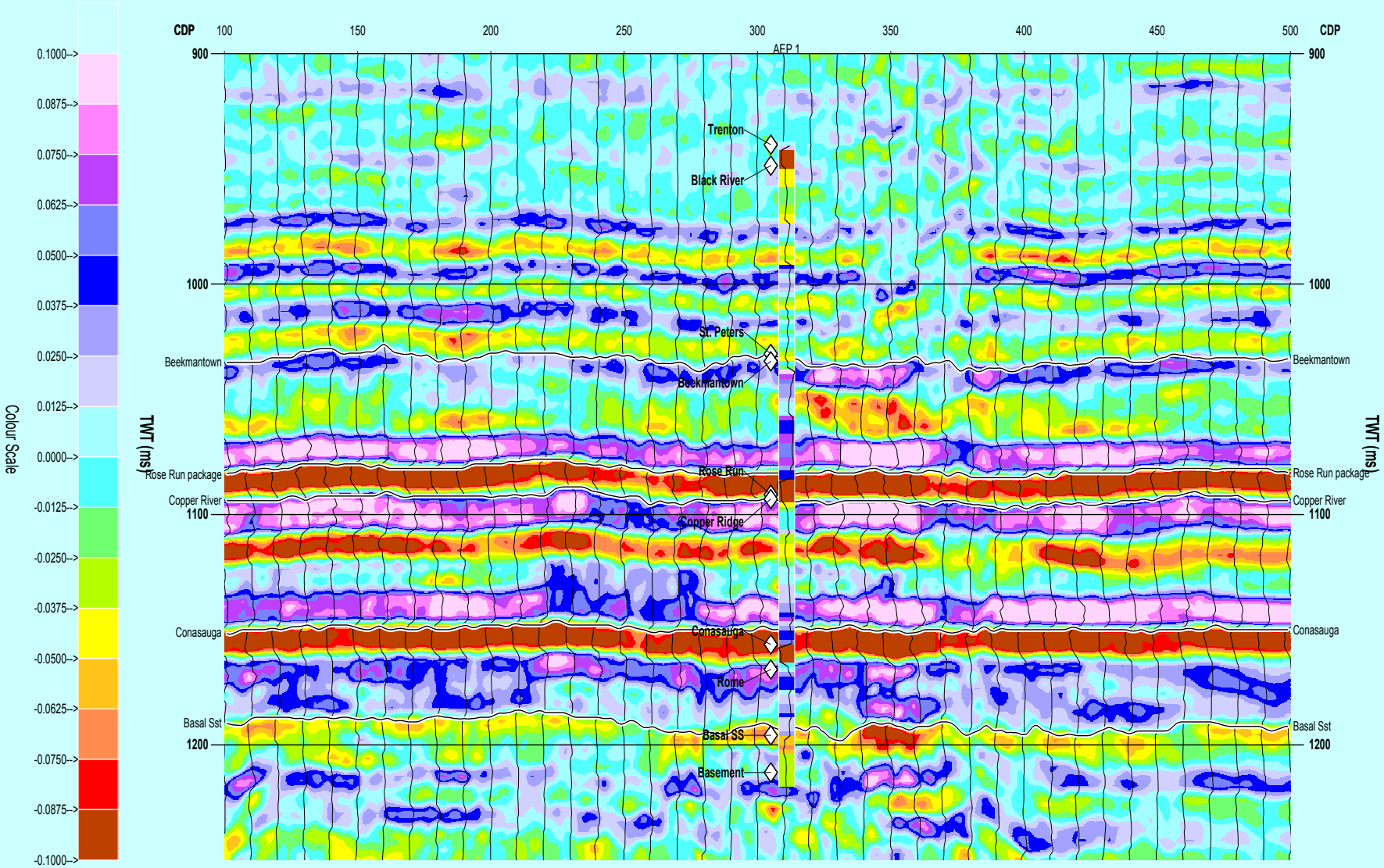
Borehole Logging – Lower Marysville Interval



Seismic Lines

- Seismic acquisition by Appalachian Geophysical
- Data processing and advanced analysis by WesternGeco
- Permitting and survey completed during summer 2003
- Approximately 11 miles (18 km) surveyed along two lines using vibroseis and dynamite sources

Line MP02-03 Interpretation Close-up



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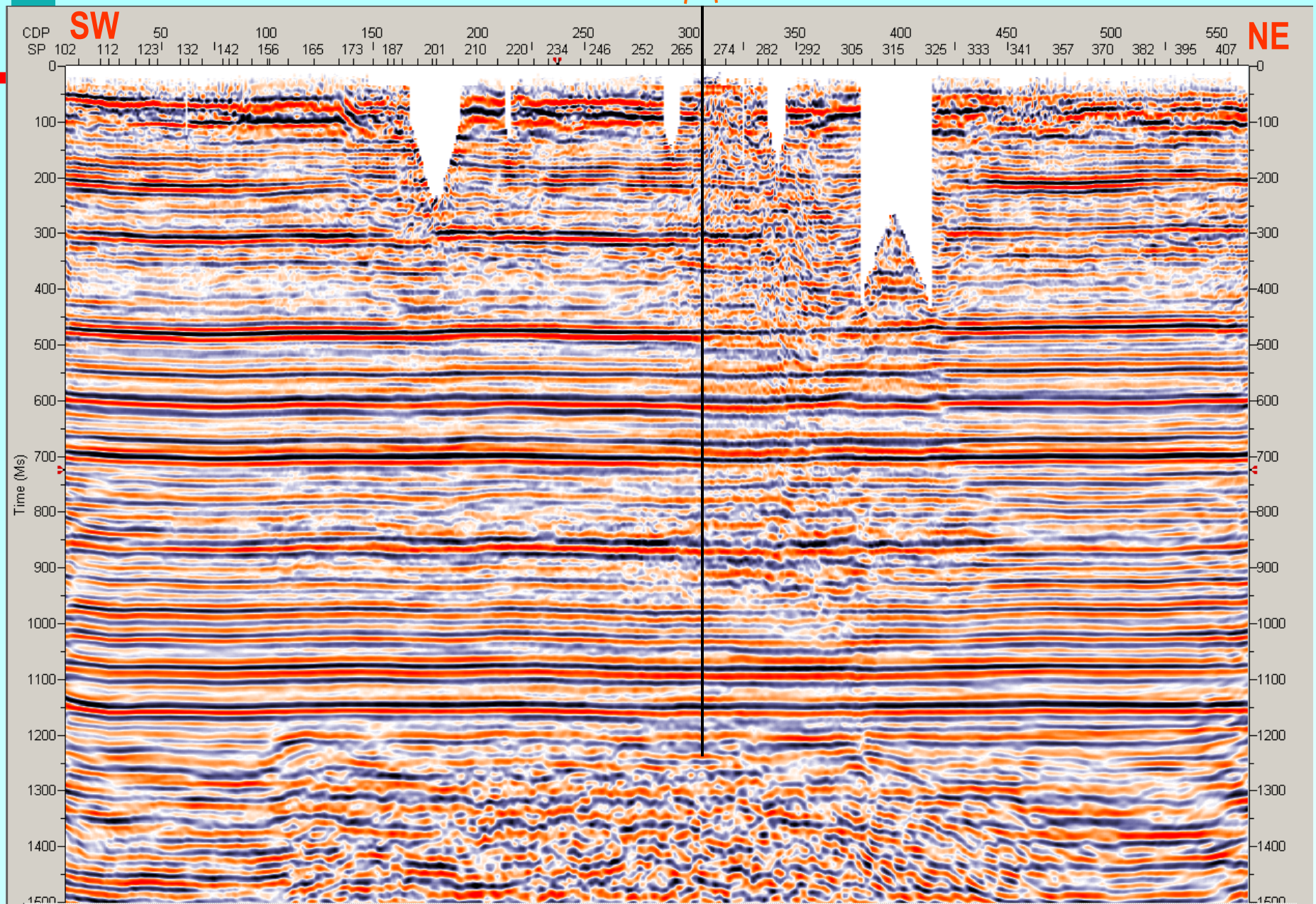
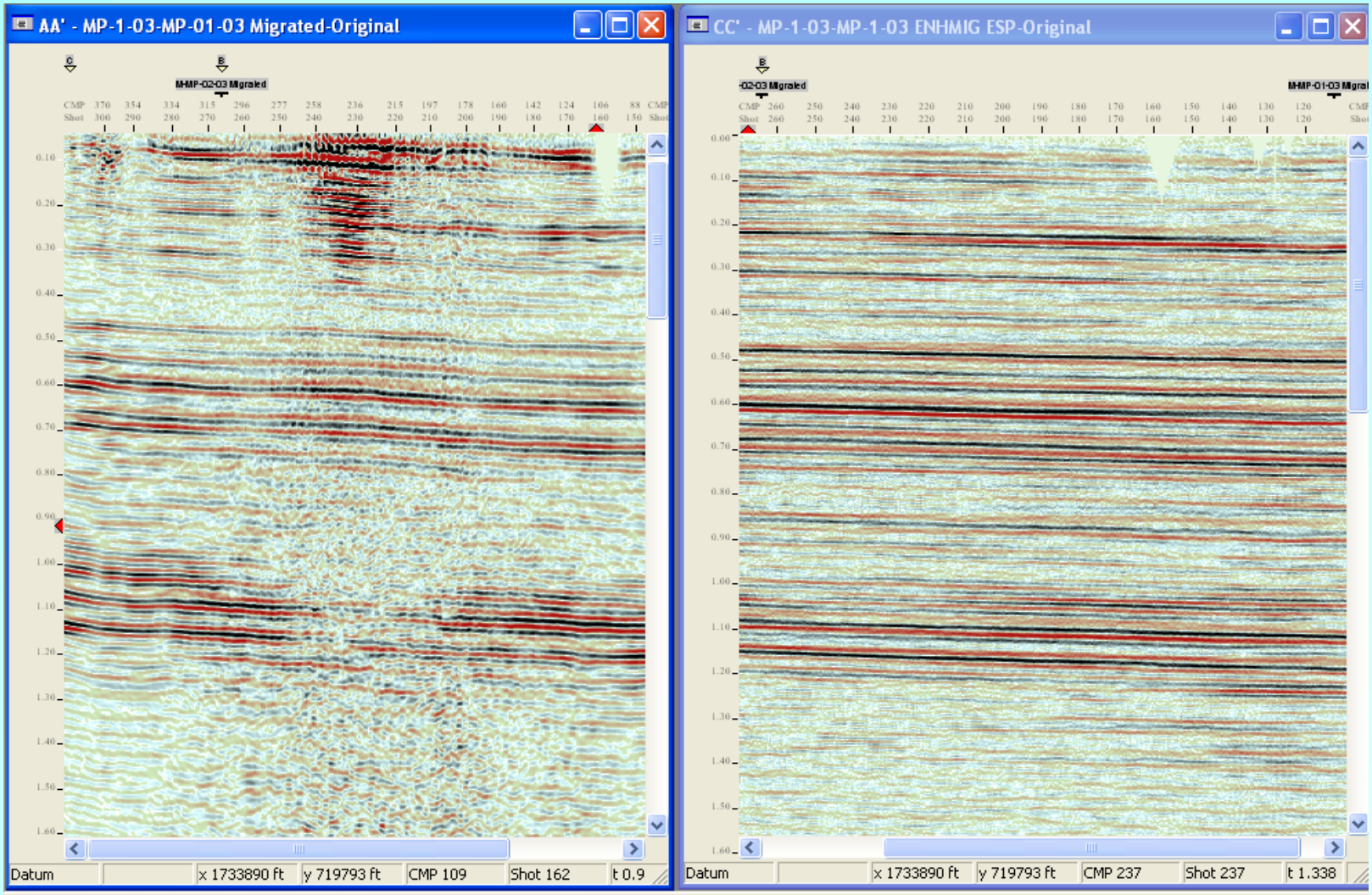
MP-02-03 Migration

Note: Well placement is approximate only



Removing the Effect of Plant Noise



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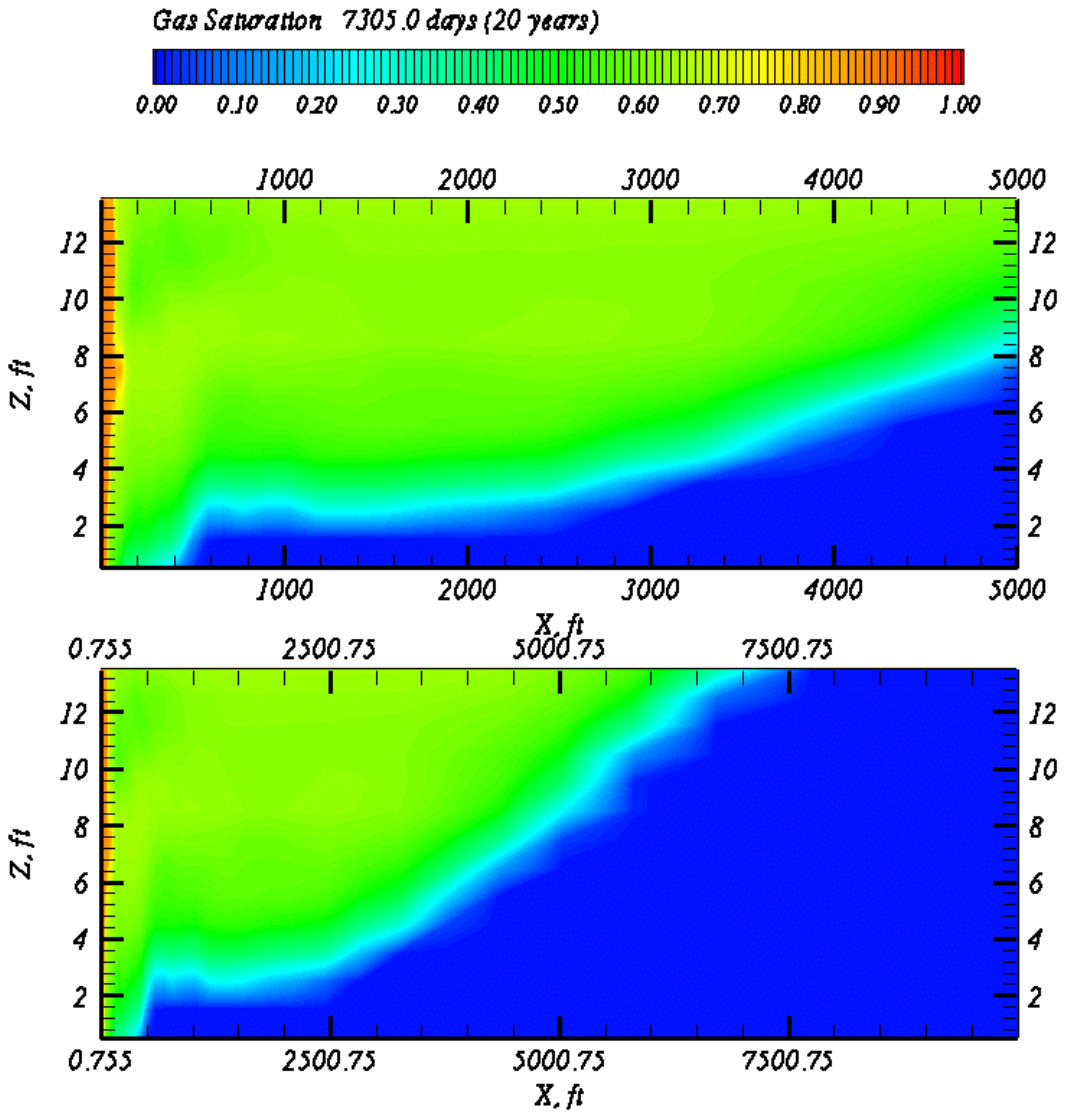
Reservoir Tests and Brine Collection

- Completed pressure measurements, permeability tests, and fracture tests in several potential injection zones and confining zones
- Results to be used for determining maximum injection pressures, amounts, and stimulation strategies
- Collected brine samples from Rose Run Sandstone
  - TDS ~328,000 mg/L, mainly Na-Cl brine with some Ca and K

Simulating Injection Scenarios

- STOMP-CO_2 developed at PNNL
- Example - 14-ft Sandy zone in Rose Run
- Stochastic permeability based on field data
- 20 years of injection



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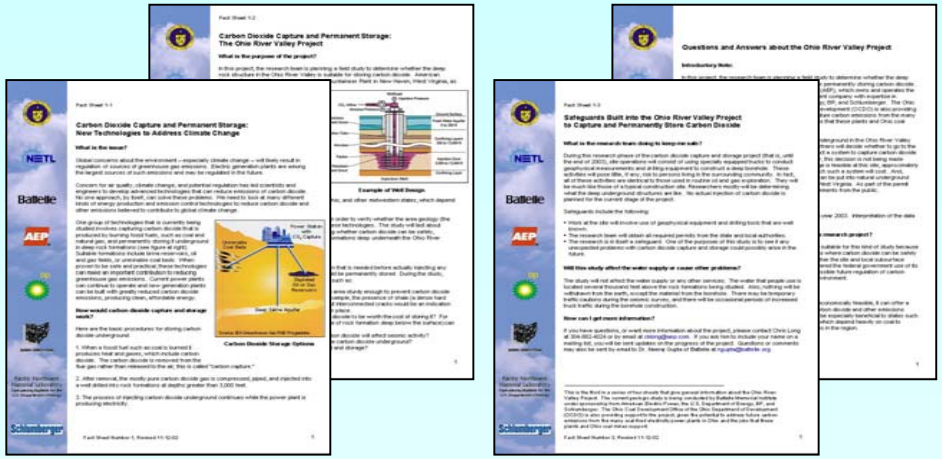
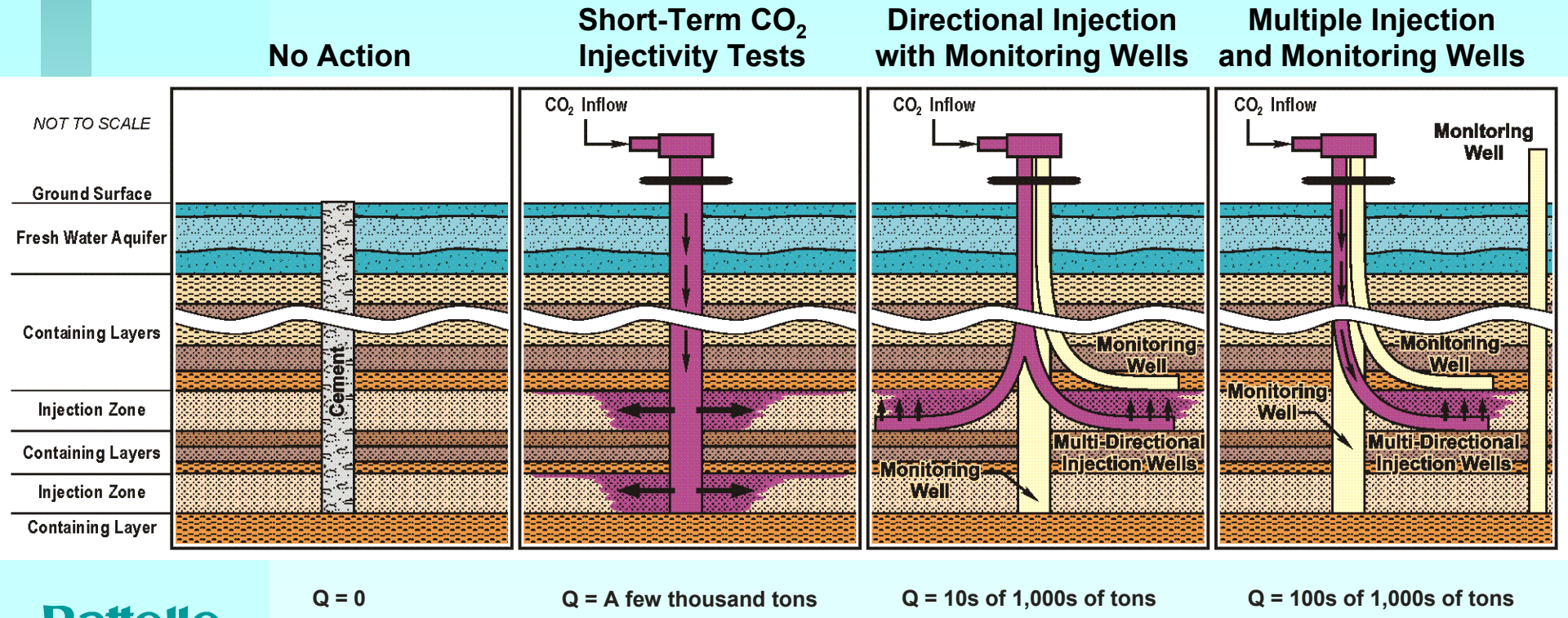
Proactive Stakeholder Outreach – A Shared Responsibility

- Numerous meetings by Battelle and AEP personnel to inform key stakeholders about the project
  - Plant managers and employees at and near the power plant
  - Local, state, and federal officials
- Coordinated press releases
- Regional and national NGOs
- Scientific meetings/workshops
- Extensive media coverage



Potential Scenarios for Future Phases

- No decision has been made about the next phase of the project, however options for an injection phase are being evaluated
- This decision will be made by project sponsors based on numerous factors
- AEP concurrence will be a prerequisite for injection phase



Q = 0 | Q = A few thousand tons | Q = 10s of 1,000s of tons | Q = 100s of 1,000s of tons

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Major Accomplishments by September 2004

- Determination of key geologic features near the Mountaineer Plant
- Quantification of CO_2 disposal potential in the vicinity of the Plant
- Characterization and construction of a deep well suitable for injection
- Reservoir simulations
- Design and monitoring plans for CO_2 injection experiments
- Preparation of regulatory information
- Implementation of a stakeholder dialogue process and development of stakeholder-accepted protocols for future CO_2 disposal projects

Conclusions

- The Ohio River Valley CO_2 storage project links strong scientific principals and applied research with technical and financial support from key stakeholders
- The project is located in an area where reduction of CO_2 emissions is critical for continued use of fossil-fuel based economy
- There seems to be limited injection potential but excellent containment at this site
- Commercial-scale injection at the site may be challenging, however it provides an excellent opportunity for scientific-scale injection tests
- There is not substitute for adequate site characterization at both local and regional scales

Mountaineer Power Plant